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MAJOR TOPIC NO. VI

STOCK TAKING IN THE TECHNICAL ASPECTS OF FIRE CONTROL

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MAJOR TOPIC VI. SUBTOPIC A.

HOW DO WE STAND IN RESPECT TO MEN AND FACILITIES IN FIRE RESEARCH?

Answering this question requires more than a mere tabulation of numbers and dollars if we are to get a true picture of the situation. At least three things need to be considered together: First, the stage of development of fire control as it affects the kinds and degrees of knowledge needed for continued advance. Second, the numbers of people and operating facilities devoted to fire research effort. Third, the qualities in these people that determine their capabilities for producing the kinds of research results needed.

These factors are ever-changing in relation to one another and the particular combination at any time determines in large part how research stands at that time. This can probably be best illustrated by a brief review of typical periods in the past in each of which different combinations of the factors prevailed.

<u>Period 1910-1915</u>

Fire control was a new activity operating over much of the country on a trial and error basis. No personnel were employed for research alone. None-the-less, a few pioneering individuals with mostly full-time administrative loads and only limited-time assignments to administrative studies contributed much toward rapid advancement and systematizing of the fire control job. Among these were such men as

Graves, then Chief; Adams, Plumber and DuBois[1]. All of them were analysts of their own experiences. A few also had vision and imagination that carried their thinking and conclusions far beyond their times. DuBois' 1914 publication, "Systematic Fire Protection in the California Forests," could well be reprinted under a 1954 date line.

This period, then, was characterized by newness of protection as an organized activity, few people devoting conscious time to technical developments, and for the most part limited to those who in addition to their administrative loads were able to interpret and codify their personal experiences in useful form. Large contributions were made in such things as fire fighting methods, organization of lookout detection systems, and many other basic protection problems.

Period 1916-1920

Fire control was still undergoing growing pains with local planning and action resting heavily on the personal experiences of field personnel. But there was growing recognition of the need for technical research. Clapp prepared the first broad working plan for fire research. Show carried out field experiments in fire behavior. Headley made an intensive study of fire control objectives and of the economics of fire control. The first real groundwork was being laid for future, more intensive investigations.

1/ In this chronological review individuals are named who are familiar to most of us and who made important contributions. The list is not exclusive and recognizes that many others unnamed have contributed in large measure to the technical knowledge reviewed in the preceding subtopic.

The individuals involved were still few and scattered. Most were busy administrators, though Show and a few others were forest technicians assigned full time to forest management (including protection) administrative studies.

The period was thus marked by the beginning of technical research on a limited scale carried on mostly by a few administrative personnel.

Period 1921-1928

Fire control was experiencing many ups and downs at the beginning of this period but by the end had assumed, in the West at least, a relatively stable pattern similar in most basic respects to that which prevails today. Better financing allowed more intensive protection and recognition of the need for correspondingly intensive research became general.

During this period the Branch of Research was growing too and making important contributions to fire knowledge as the research organization expanded. The number of full-time fire researchers was not large, yet total productivity was impressive. Gisborne and Stickel got major works under way. Unique to this period was the teaming up of the two renowned pairs, each composed of an administrator and a researcher, in the Northwest and in California. Hoffman and Osborne in the former and Show and Kotok in the latter. While the first pair was relating fire danger to relative humidity as a basic index, the second pioneered in analyzing past effort and accomplishments as a valuable guide to future action.

A wealth of fire control experience coupled with the formal disciplines of the research method was probably the outstanding reason for the major contributions to fire knowledge of the period.

Period 1930-1932

The status of fire control in general probably differed little in this period from that of the late '20s. Passage of the McSweeney-McNary Act of 1928, however, strengthened research financing in a major way and by 1930 Fire Research could stand on its own feet. Increases in research manpower came largely from reassignments from administrative jobs. The research activity thus still leaned heavily for its background on fire control experience. Regional study programs were expanded and much of the groundwork was laid for the major progress that came in the next period.

Period 1933-1940

Advent of the CCC and other emergency programs created a wholly new situation in fire control. Money and large labor forces were available, permitting development of long-needed facilities as well as providing a vast source of organized fire fighting manpower.

Fire research also benefitted from these programs, expanding in a number of directions. Of first importance was the need to assure orderly and systematically planned development of the new facilities. Fire control planning in which administration and research forces joined led to new planning methods and devices.

At the same time it now became possible to employ specialists

outside the forestry field for fundamental research on many detailed aspects of the fire problem. These included chemists, physicists, engineers, botanists and other specialized people, many of whom had wide research backgrounds. Byram brought a new analytical approach to many of our basic fire problems and has continued in the lead in this research method through the years. Fire behavior research was given great impetus because for the first time large enough forces were available to make effective attack on many of its complex problems. Gisborne's first fire danger meter was born. Hornby brought together his own previous work and that of Norcross, Sparhawk and others into a new integrated form of systematized fire control planning.

This list of accomplishments is only a sketch of the types of progress made during the period. Both fire control and fire research made major advancements, with fire research assuming its full responsibility for technical studies but with close cooperation between administration and research prevailing everywhere.

Period 1942-1946

World War II again changed the whole national fire control picture. The CCC men and dollars had vanished and fire control was faced not only with holding the gains made, but with the constant threat of enemy induced fire.---and all this with a reduced regular force. Loss of the organized and trained CCC crews again required that fire control revert to the use of unseasoned green men for much of the fire load. A truly remarkable job was done.

Fire research appropriations meanwhile were drastically curtailed. Many going fire studies were shelved and the few career fire researchers remaining on the payroll devoted a major part of their time to war problems. P&M dollars were contributed to the extent necessary to maintain research units at most stations in a live, even though dormant, status. Post war planning was probably the most outstanding accomplishment.

Period 1947-1954

This is the most difficult period in our fire control history to assess. Large strides ahead in the thirties, retrenchment in the War Years, trend toward more heavy equipment, and many complications of the post war era that have hindered recovery, complicate the problem of defining just where fire control stands today. Our previous topics have pretty well covered the general situation. General concensus is that the field of fire protection is now beginning to mature. Accepted ways of doing things are becoming well entrenched. People are now relearning what a former generation learned before them, rather than learning new things. The cream has been skimmed. The obvious ways to improve fire control have been developed and applied. But the Service cannot be satisfied with today's fire control accomplishments even though there is evidence that some have been great in recent years. There are still too many areas where, in spite of large protection expenditures, damage from fire still occurs in disastrous amounts.

Now, where does fire research stand in respect to this?

Last fiscal year the fire research appropriation was $133,104. As nearly as I can tell, this supported 11 men in the Experiment Stations having fire research units. Fire control funds have supported additional researchers such as Keetch, Crosby, Lindenmuth, at Asheville, Columbus, and Albuquerque and detailer Intorf at Berkeley. They have also contributed to the support of the general research program at some Stations.

The military services are also cooperating in the fire research effort through a Washington office project. This work is giving us some new knowledge that will lead to development of useful fire control tools.

Another large cooperative project is that carried on by Barrows, General Electric, and Munitalp Foundation in Region 1.

And finally, a major one-year cooperative undertaking known as Operation Firestop is just getting under way in California. It involves a mutual effort between Region 5, the California Station, University of California, California State Division of Forestry, Los Angeles County, City of Los Angeles, U.S. Weather Bureau, and various commercial concerns. Its objective is to learn more about mass fires and test at full scale some possible ways to stop them.

Thus, in general, as illustrated by these examples, there is a growing trend toward cooperative fire research. Some of it involves contribution of funds, but in the main--as in Firestop-- mostly contributed personnel and facilities.

There could be many more of these cooperative projects with outside agencies if we had the research people to head up the technical phases.

Some of these possibilities sound big, but to engage in them does mean restricting or curtailing work on going study programs, many of which are concerned with relatively long-term fundamental studies that are known to be essential to further advancement of some parts of the fire control job. This latter type of study is not usually attractive to cooperators. For us to join in a cooperative undertaking is thus not a simple decision to make. There are not enough researchers at present to give reasonable coverage to even the highest priority studies in the planned Station programs, hence more research personnel to carry on both types of activity is the only answer.

Most fire research problems are susceptible to solution without extensive outlays for plant facilities. Some of the more complex subjects like fire behavior, however, can be solved most quickly and effectively through a combination of analytical studies and laboratory and field experiments. One sizeable laboratory with special equipment is very much needed. There is also continuing need for specialized--and expensive--research equipment for many study projects.

In summary it can be said that if reducing both fire costs and damages is our goal, difficult, time-consuming research into all aspects of fire control seems to be the only foreseeable way to eventual, realistic solution of the problem. It will require not only strong fire research leaders but many specialists in sciences other than forestry, including specialists in human engineering.

Detailed research needs to activate such a program were analyzed and compiled in the individual Stations and Regions in 1951 and are supported by the report, "A Policy for More Adequate Forest Fire Research Program," transmitted to the field on July 18, 1952.

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Subtopic B. Proposed policy for concentrating fire research.

George M. Jemison

In 1951 the House Agricultural Appropriations Committee asked the Department of Agriculture for a special report on the forest research program and particularly on existing and potential cooperative research work with state and private groups. Following a field survey that summer and fall, a statement, commonly called the "Whitten Report," was issued in December 1951. The report covers our activities carried on under the appropriation "Forest and Range Management Investigations" which includes Fire Research.

During the preparation of the Whitten Report it was felt that Fire Research, one of the obviously poorly financed research divisions, required more detailed treatment than was possible in the generalized Report. Consequently, a thorough review of fire research programs, accomplishments, and needs was made at that time. A policy statement pointing toward a more adequate fire research program evolved from this study. It was transmitted to station directors for information and guidance July 18, 1952. Copies also went to regional foresters.

The fire research report outlined what kind of a Forest Service fire research program was needed, how it should be organized, and suggested how it might be achieved. It outlined a policy of encouraging non-Federal participation in fire research on a cooperative basis. One of the main points in the report was the proposal for a policy which would (1) concentrate basic fire research in three central units, and (2) supplement the centralized work with applied regional and local studies at other experiment stations. It is this policy of centralizing fundamental work and supplementing it regionally that is to be discussed as Subtopic B.

/The case in support of the policy mentioned is contained on pages 8 to 10 in "A Policy for a More Adequate Fire Research Program" transmitted with Loveridge's letter of July 18, 1952 designated "R-Research Program, General." The report bears the date March 7, 1952. This report should be read by those interested in this Subtopic. It need not be reviewed completely here./

Some Preliminary Considerations

Before discussing the pros and cons of centralizing certain fundamental research, there are some general points to clear up. In the past we have talked about fire research "laboratories" when we have

discussed this subject. As far as I know, no one has advocated a centralized laboratory that might be another Forest Products Laboratory where all work would be done on laboratory tables in one big building. However, a fire research center has been envisioned where necessary facilities would be available--experimental forests, timber and brush lands, buildings, laboratories in the true sense, and other facilities and equipment. I think this more general concept should be kept in mind.

Consideration of centralized fire research units does not indicate a retrenchment. On the contrary, any system of such centers would require considerably greater financing and an expansion of the program, not only at the central units but of the supplemental regional fire groups.

Then I think a few words regarding "fundamental" research are appropriate right at the start. Somehow we shy away from the thought of fundamental research. Occasionally we encounter those who feel fundamental research has no <u>practical</u> value. Of course, there can be unproductive basic work just as there can be unproductive applied work. The point to keep in mind is that we need both fundamental and applied studies in a well-balanced program. Unfortunately, it has always been difficult to keep a reasonable balance in our fire research. With some very notable exceptions, we have tended to be a bunch of cream-skimmers over the years. This cream-skimming process has really paid off too. I want to emphasize that. But there comes a time when we get down to pretty thin milk. We are approaching that point now in fire research, if we are not already there. We are rapidly running out of steam. (Cite fire danger rating as an example.) One of the things we must face in fire research is how to create and maintain an appropriate balance between fundamental and applied studies.

Advantages of Centralization

There are several advantages of centralizing certain fire research investigations at a few stations. The fire research report previously mentioned summarizes most of these points.

First, many of our basic problems are national in scope or at least interregional. There is no need for duplicating in every region work on such things as the principles of combustion, atmospheric turbulence, visibility of smoke, or many other fundamental subjects. We have seen some cases where outstanding progress has been made through a fundamental approach. Byram's work on smoke visibility is equally applicable to West or East, for working out ground or aerial detection systems. The principles have been well established. Some of Fons' work on rate of spread is in the same category and there are other examples that could be mentioned. To the extent that studies are basic to several regions or to the nation, centralization would be desirable.

A second, and perhaps the most important argument in favor of central fire research units, is that it makes possible a task-force approach. There is nothing particularly new about task-force research. All of the large and successful industrial and defense research agencies use it. During the war it proved its worth. "Business Week" for October 24, 1953, contained a good article on "How a Research Team Combines Forces." It described one case in which Westinghouse wanted to develop and test a new material for air brake systems. They employed a task force consisting of:

1. A physicist to head the team because wear is basically a mechanical problem.
2. A chemist to focus attention on the composition and properties of an array of available materials.
3. A mechanical engineer to design special equipment to test wear.
4. An instrument specialist to develop instruments for special test measurements.
5. A theoretical physicist to advise on theoretical aspects of wear.

The article aptly points out that the days of Thomas Edison are gone--no one man can master all fields and do the entire job alone any more.

Many of our problems today, such as understanding the complexities of fire behavior, will require the task-force approach for solution. Concentration of the highly technical phases of the work at a few stations will enable us to afford highly trained chemists, physicists, and meteorologists--personnel that are expensive and not very plentiful.

Another closely related point in support of the centralized plan is that it offers a way to develop and maintain a satisfactory balance between fundamental and applied research. In some past instances, where we have had men capable of doing fundamental work, the pressure to do applied research has taken precedence on their time. The result has sometimes been the continual postponement or interruption of basic studies or the misassignment of technical workers. However, if we were to accept the principle of creating central units to handle fundamental research and were to establish research teams, there would be little reason to use these workers on anything but their basic research assignments.

Finally, because cooperation generally can be expected to increase as strength of primary research units increase, a centralized attack on some problems will create greater opportunities to attract cooperative research by other agencies.

Applied Research at Other Stations

The special fire research report discusses the need for and scope of fire research at other than the centralized units. In summary, it points out that a concentrated attack at a few stations cannot fulfill all the needs. Therefore, it will be supported by applied research programs at the other stations as problems and opportunities indicate. The needs by Regions will vary but the supplemental programs will all be aimed at adapting the results of basic research to Regional and local problems. For example, centralized studies may show that certain key factors of fuel volume and arrangements are fundamental in any fuel type classification. Regional and local studies would be necessary to fully identify these values on the ground and to build up a Regional fuel type identification key. The principles for planning a detection system with either aerial or ground observers might be developed in one Region but their adaptation to the specific needs of other Regions would require further study. Research on an applied basis at other Stations will vary in scope, depending upon the importance of fire to Regional programs, on the prevalence of distinctive fire problems and on the difficulty of applying findings from basic studies to specific situations. These things will determine general priority in setting up applied fire research programs.

The type of service most needed will determine how it will be organized within the Station territory. As priorities in financing permit, one or more qualified technical fire research men will usually be attached to the Station headquarters staff to plan and coordinate fire studies and to maintain liaison with the fire agencies of the Region. Organizationally, these subject matter specialists would ordinarily be assigned to the most appropriate resource management research division. In addition, it will be desirable to assign fire research men to research center staffs for certain problem areas and to provide for participation of research-center personnel in some fire studies, particularly those concerned with use of fire as a management tool. Fire studies within the problem area will usually be closely related to land management problems and can best be supervised by the problem area leader under the general direction and review of the Station Director and his staff specialists.

Need for Careful Programming and Coordination

It is quite obvious that if the proposal, as outlined, is to work, a careful job must be done in developing the programs at central units. This job would take some strong leadership nationally and certainly would be a joint responsibility of all regions and stations. The programs at the central units would have to be developed on a well coordinated basis or should reflect the highest priority national and interregional needs.

Likewise, a well coordinated program of applied and local research would have to be developed in every region and at all the stations.

Where Would Centralized Fire Units be Located?

The 1952 fire research report recommended that three centralized units be established at the Southeastern, Northern Rocky, and California Stations to cover fundamental work in the East and South, interior Rocky Mountain region, and Pacific Coast region, respectively. These three stations have handled the greatest amount of fire research in the past. Two thirds of the meager F.Y. 1954 allotment went to them. The Pacific Northwest and the Lake States Stations have been prominent in fire research, too, over the years, with some excellent but more limited work at the Southern, Northeastern, and other stations.

If we are to build up strong central units, they obviously must be limited in number. Three would seem the greatest number we would need and could afford under any reasonable financing. Three seem to be justified from the geographical viewpoint and from the way problems tend to break down regionally into South and East, Interior West, and Pacific Coast.

Discussion

Before opening up the topic for discussion, I might summarize for you the reaction of Regions and Stations to the question of centralization. Replies to an inquiry are not complete and in a few cases were not expressed definitely for or against. At any rate, six Regions and three Stations were in favor, one Region and one Station against, and two Regions did not give a definite opinion. With that as a basis, we can proceed with further consideration of the subject.

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Subtopic C. High Spot Review of How We Stand in our Technical Knowledge and its Application on the Job.

This subject will be presented as a panel discussion. The moderator is George M. Jemison. Panel members are Charles Buck and Jack Barrows.

Subject matter will be divided as follows: (Name of panel member indicates primary responsibility for discussing topic.)

1. Fire Behavior

   a. Basic knowledge of ignition and combustion. What have we learned about the fire triangle as applied to forest fires? (Buck)

   b. What have we learned about the influence of weather, fuels, and topography on fire behavior? (Barrows)

   c. What about blow-up fires? Do we understand why they blow up? Can we make accurate predictions of when and where fires may blow up? (Buck)

   d. What about general predictions of fire behavior? Can we evaluate conditions well enough to alter dispatching and initial-attack patterns according to fire behavior? Are so-called rate-of-spread computers successful? (Barrows)

   e. What do we know about mass fire and fire storms? (Buck)

   f. Where do we stand in the development of fire behavior training aids, manuals, motion pictures, etc.? (Barrows)

2. Fire Weather and Fire Danger Rating

   a. What have we learned about the measurement and interpretation of weather? (Barrows)

   b. What about weather forecasts? Are they improving in accuracy? How can we use them to greater advantage? Are long-range forecasts useful to fire men? (Buck)

   c. Where do we stand in the United States in the development of fire danger rating systems? What are the opportunities for standardization of fire danger meters? (Barrows)

   d. What can be done to promote better and more effective use of fire weather and fire danger rating information? How can this information be used more effectively in fire-control planning? In dispatching? In reducing suppression costs? In safety? (Buck)

3. Fire Prevention

   a. What are the significant trends in man-caused fires? What have we learned about the major problems influencing the occurrence of man-caused fires? (Barrows)

   b. What have we learned about the effectiveness of various fire-prevention measures? (Buck)

   c. What have we learned about the identification and reduction of dangerous fuels as an effective aid in fire prevention? (Barrows)

   d. Have we learned how to carry on prescribed-burning operations as a fire-prevention tool? (Buck)

   e. What are the possibilities for preventing lightning fires? (Barrows)

4. Fire-Control Planning and Management

   a. Where do we stand in knowledge of fire-control planning methods and techniques? (Barrows)

   b. What have we learned about watershed evaluation and fire damage that will aid in planning more effective and economical fire-control measures? (Buck)

   c. What about so-called operations research? Can it help in the day-to-day jobs of fire-control management? (Barrows)

   d. Can operations research help us do a more effective planning and management job on large fires? (Buck)

5. Fire Detection

   a. What has been learned about basic principles of visibility and illumination? How does this knowledge influence the planning and management of fire-detection systems? (Buck)

   b. The Forest Service now has records on the detection of thousands of fires. What do these statistics show? Do they provide some vital information on fire detection? (Barrows)

   c. What has been learned about planning the location, equipping, and operating lookout stations? (Buck)

   d. What has been learned about the operation of combined aerial and ground detection systems? (Barrows)

6. Fire Suppression

a. What has been learned about fire behavior which can influence fire-suppression strategy and tactics? (Buck)

b. Where do we stand in technical knowledge of fireline location and construction? (Barrows)

c. What has been learned about the use of water in fire suppression? What about chemicals? (Buck)

d. What about aerial bombing of forest fires? (Barrows)

e. Where do we stand in our knowledge of when, where, and how to backfire? (Buck)

f. How can the efficiency of mop-up operations be improved? (Barrows)

g. What have we learned about fire-suppression personnel requirements? Have we gained key information that should guide us in recruiting, training, and supervising fire-fighting personnel? (Buck)

h. What have we learned about the efficiency of fire-fighting equipment? What is the influence of power equipment on fire-fighting techniques? (Barrows)

7. Fire Control and Forest Management

a. What is the impact of greatly increased logging activity on the fire-control job? (Buck)

b. Where do we stand in our knowledge of the inflammability of logging slash? Are more economical and effective methods being developed for logging slash disposal? (Barrows)

c. What basic information has been developed on the prescribed use of fire in fuel reduction? What about the use of fire as a silvicultural tool? (Buck)

d. Where do we stand in the training of personnel for prescribed use of fire? (Barrows)

8. Fire Effects

a. Have we learned how to evaluate fire damage? (Buck)

b. What do we know about the role of fire in ecology? (Barrows)

9. Fire Economics

a. What have we learned about the soundness of various fire-control objectives -- the 10:00 a.m. policy, burned area pars, etc? (Buck)

b. Have we learned how to determine justifiable costs of fire control? (Barrows)

c. Can we determine appropriate balances for the costs of prevention, presuppression, and suppression? (Buck)

10. Application of Technical Knowledge

a. How good a job are we doing in applying the technical knowledge of fire control? (Buck)

b. What has been learned about the best methods for dispensing technical knowledge of fire control? (Barrows)

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Subtopic D. What are the priorities in fire management and what can be done to bring fire research into better balance with the action program?

George M. Jemison

One of the main purposes of the Ogden Fire Conference will be to determine the principal features of fire management that need strengthening. Consequently, Subtopic D will necessarily be a summary and a tying together of the stock-taking in preceding discussions, particularly Major Topic I. Any complete analysis of fire management priorities would be premature at this stage. Instead of attempting a thorough analysis at this time, the following outlines a plan for handling the topic and gives a forecast of some points that may come out of the meeting. An important part of the discussion will be an evaluation of the extent to which current research is now satisfying or will satisfy the needs of fire management.

Subtopic D will start out with a summary of the problems the fire manager faces--problems that are obstacles to improved fire control. The questions to be answered throughout the discussion are:

1. Which of the problems brought out in Topics I to V must depend upon Research for the answers?

2. Which of them are already covered by going projects and plans in the current research program?

3. Which of them require speeding up for quicker answers than can be obtained at the present level of research effort?

4. What new studies need to be undertaken?

5. What order of priorities, both on going projects and on new work, can be agreed upon?

6. What can be done in cases where the existing fire research organization is not supplied with facilities necessary to do the job?

Problems Needing Research

A pre-meeting questionnaire to Regions and Stations brought in incomplete replies but indicated some general agreement as to research needs stemming from fire management problems. Western Regions, particularly, stressed the need for work in (1) fire-control planning,

(2) fire behavior, and (3) logging slash problems. Eastern Regions rated damage appraisal and fire economic studies high. Some eastern and western Regions put fire danger rating well up on the list of priorities.

The following represent major fire management problems which fire research can help solve:

The logging slash problem

Accelerated cutting and increased costs of slash disposal emphasize the need for a sounder program of slash disposal. Information is needed as a basis for developing a policy on (1) how much slash needs treatment, and (2) best methods to use. Specific answers are required on (1) inflammability of slash by species, volume, condition, arrnagement; (2) volumes produced in logging various amounts and kinds of timber; (3) rates of decomposition and how they can be accelerated; (4) methods and techniques of slash disposal with comparative cost.

Research is underway now at the Northern Rocky Mountain and Pacific Northwest Stations on at least some of these questions but speed-up and more adequate coverage of all problems is needed.

Fire detection

Analysis shows that we are having an increasing number of detection failures or instances where detection performance has been inadequate. Part of the reason may be due to a change-over from ground detection to air or to a combination of air-ground. Air detection plans have not been built on the same quality of research information as were the ground detection plans of 15 years ago. Research is needed to develop sound standards and methods of air detection.

Virtually no current air detection planning studies are underway. We have a good backlog of fundamental information on visibility but need new and complete detection planning studies, starting with an analysis of current detection systems and their weaknesses.

More efficient use of presuppression forces

With limited manpower and the changes in presuppression organizations which have gradually taken place over the years, there is a feeling that fire management can be improved through more efficient use of presuppression guards, crews, and overhead. One thing that is needed is a more reliable danger rating system region by region. While not universally true, it is felt that existing meters need considerable refinement to permit full confidence to be placed in them. Research on danger rating has been underway a long time. Most regional systems are empirical. While some improvements can undoubtedly be made by further empirical revisions, in many cases a more basic approach is

indicated. If this is so, greater facilities are needed if the job is to be handled in a reasonable time. From here on out, refinements in danger rating are likely to come slowly without more adequate manpower.

Additional work needs to be done on other aspects of presuppression planning to get the most out of facilities and equipment available today. Situations have changed so drastically in the last 10 to 20 years, through transportation and equipment improvements, that old fire plans, in many cases, are obsolete.

Initial attack and first reinforcement action

Weaknesses in initial attack and in first reinforcement action have either resulted in fires escaping or in costly overmanning. The weakness is in part traceable to an inadequate job of dispatching and points to a better understanding of fire behavior in relation to fuels, weather, and topography.

Predicting the behavior of every fire which requires suppression action is surely a desirable goal in fire management. Until we learn how to do this with a reasonable degree of success, we cannot expect to be efficient in the over-all fire-control effort. At present our batting average on predicting fire behavior is something like this:

1. We identify the very obvious slow-spreading and fast-spreading fires.

2. A few individuals which much experience identify up to 75 percent of the very slow-spreading fires and about half of the fast-spreaders.

3. The general rule is to handle all fires in somewhat standard fashion in initial attack and wait for something to happen before identifying the fire as a potential trouble maker.

We could greatly improve this batting average by doing three things:

1. Do a better job of applying what is already known about fire behavior.

2. Establish a procedure for altering the initial attack pattern to fit the predictions of fire behavior.

3. Do more research on (a) predicting fire behavior and (b) tailoring suppression methods and strength of attack to fit the fire behavior situation.

Developing an adequate understanding of fire behavior is rated high in priority but is a tremendous research job. Much fundamental work is involved. Current programs include some studies of fire behavior, but efforts are entirely inadequate. A good understanding of behavior

bears on many problems other than initial attack. Successful suppression of large fires, safety of personnel, and use of fire all depend, in a major way, upon a good knowledge of fire behavior.

We need better information on the fundamental aspects of combustion, evaluation of fuel factors, air turbulence, and the effect of topography on rate of spread of fire behavior in general.

Operations research

During the war there was developed, to a high degree, the application of research techniques to operational problems. We believe there is a place for an analytical approach to some of the organizational problems and operations connected with fire suppression. The principle involved in operations research is one in which masses of data are analyzed to determine the likelihood of failures in each phase of a complex operation. The probability of failure can be ascertained and the weakest spots in each organization identified. Time-study techniques, statistical methods, and other analytical procedures are involved. Since many of our costly fires may be due to breakdowns in organization or failure for team action to function properly, this approach might pay off.

Prescribed burning

Proper use of fire to convert one type to another, to reduce fuel hazard, for disease control, or for other reasons, is an integral part of management. More effective use of fire requires a better understanding of when and how a desired effect can be accomplished. Guides and techniques are badly needed if we are to push along with efficient and widespread prescribed burning.

A better understanding of fire behavior is essential to improvement of prescribed burning techniques. Studies of fuels, fuel condition, topography, and wind in relation to fire behavior, need to be strengthened materially.

Economics of fire control

At least one region has indicated that determination of the optimum balance between costs and losses rates top priority. Other regions have rated damage appraisal high, which is all part of the over-all question of what is the most profitable fire-control expenditure.

One of the stickers to progress in fire economics is the absence of suitable techniques to evaluate effects of fire on soil, water, and recreational values. More is known about effect of fire on timber and forage, but perhaps not enough. Thus we not only need better information on the physical fire effects but we need to develop or apply to this specific job techniques of evaluation of fire effects.

Although one or more of the eastern stations is working on this subject, current effort is entirely inadequate.

Improved fire prevention

A high percentage of the most costly and damaging fires are man-caused. Our biggest losses come from relatively few lumbering, railroad, debris burner, or camper fires. For example, in 1952, all except three of the 109 Class E fires in national forests were man-caused. What special facts need to be known to help prevent such fires? Is it merely a question of administrative action? Do we need better information on how to identify the times when and the conditions under which these fires start? Can Research contribute to prevention methods and to the evaluation of prevention success?

Lightning causes over eight thousand fires each year. We should pursue cooperative work with other research organizations to find preventative techniques applicable to lightning fires.

A Better Balance

How can we bring fire research into better balance with the action program? This question is a major part of Subtopic D but one that can be answered rather quickly once we have agreed on what research service the action program needs and what are the priorities. After completing the discussions at Ogden up to this point, we shall have arrived at needs and priorities.

Analysis of research facilities and personnel available quickly shows how inadequate our resources are to make any satisfactory showing on even the high priority jobs. What can be done? Obviously we need better fire research financing, something that has been recognized and emphasized at every fire conference of the past 25 years. We need to create a type of fire research organization that will attract the best fire men and provide a set-up for career service in fire research. The task-force attack will be needed on some important problems. The proposals of Subtopic B for centralizing certain fundamental work at research centers will help create a better balance in fire research and hence tie in more adequately to the action program.

There can be all kinds of estimates of the fire research facilities needed to achieve balance between investigations and action programs. One estimate is as follows:

3 Special fire research centers		
6 men at each at $12,000/man,	$72,000	$216,000
7 Other regional fire groups or equivalent		
2 men each at $10,000/man,	$20,000	$140,000
1 Strong W.O. division		
2 men at $15,000 each		$ 30,000
		$386,000